M10321X

INSTRUCTIONS

for the

MODEL 710

LINEAR AC TO DC CONVERTER

BALLANTINE LABORATORIES, INC.

BOONTON, NEW JERSEY

E/E SYSTEMS LABORATORY

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INSTRUCTION BOOK FOR MODEL 710
LINEAR AC TO DC CONVERTER
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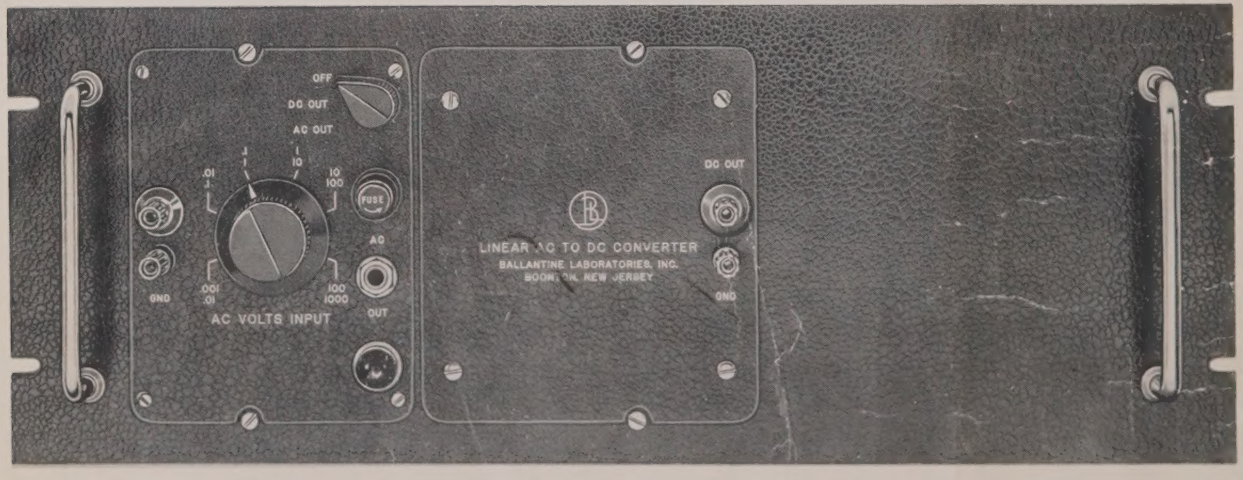
Model 710 Linear AC to DC Converter



Relay Rack Panel Version
Model 710-S/2

1. SPECIFICATIONS

BALLANTINE MODEL 710

LINEAR AC TO DC CONVERTER

AC Input

Voltage ..... 1 mV to 1000 V in 6 decade ranges
Impedance .... 2 MΩ shunted by 15 pF except
25 pF on the most sensitive range
Frequency .... 30 cps to 250 kc

DC Output

Voltage ..... 0.1 to 1.0 volts dc for each decade range with 1 MΩ load
Impedance .... approximately 10 kΩ

Accuracy	0.001 to 250 Volts	250 to 1000 Volts
50 cps to 10 kc	±0.25%	±0.50% with correction (See Sec-)
30 cps to 50 kc	±0.50%	±0.75% with correction (tion 3.6,)
50,000 cps to 250 kc	±1.00%	±1.25% with correction (Page 5)

AC Output

Voltage Gain ... 60 db maximum
Voltage Output.. 1 to 10 V for each decade range
Impedance ..... approximately 300 Ω
Loading ..... 15 kΩ impedance maximum
Response ..... ±1 db, 30 cps to 250 kc

Power Supply

115 - 230 V, 50 - 420 cps, 35 W

Tubes

4 Type 6AU6WA, 1 Type OA2, 1 Type 6X4

Standard Finish

Panel - black crackle; Box - black wrinkle

Dimensions

Portable - 6 inches wide, 11 inches long, 7 inches deep
Rack - 7 inches wide, 19 inches long, 7 inches deep

Weight

Instrument alone, 10 lbs. - packed for shipment, 15 lbs.

2. GENERAL DESCRIPTION

The Model 710 Linear AC to DC Converter has been designed to convert ac potentials, from 1 millivolt to 1000 volts over a frequency range of 30 cycles to 250,000 cycles, to dc. The dc output may be measured with a potentiometer, digital dc voltmeter, or other high input impedance dc-responding device.

Essentially the instrument comprises an input attenuator followed by a degeneratively stabalized amplifier which feeds an average-responding rectifier circuit.

The amplifier output may be disconnected from the rectifier circuit and made available at an output jack on the front panel of the instrument. The control permitting this also serves to turn the instrument on and off.

3. OPERATION

3.1 Power Connection and Warm Up

Connect the power cord to a source which conforms with the requirements stated on the decal located where the cord leaves the instrument case. Rotate the function switch to either the DC OUT or AMP position and allow a warm up period of several minutes, unless the instrument has not been in use for many months, in which case allow a warm up period of at least 30 minutes.

IT IS IMPORTANT THAT AIR BE ALLOWED TO CIRCULATE FREELY AT ALL SIDES OF THE INSTRUMENT, AND THAT NO SOURCES OF HEAT BE PLACED DIRECTLY AGAINST THE INSTRUMENT CASE.

3.2 Input Impedance

At low frequencies the input terminals present a constant resistive component (2 megohms ±1%) to the input signal, while the capacitive component is a function of the range switch setting and is given in Table I. Although the capacitive component is essentially independent of frequency, the resistive component decreases as the higher frequencies are approached. Figure 1 shows the approximate variation of input resistance vs. frequency.

Although the instrument is designed to withstand rather severe overloads without damage, there are limits to the maximum input voltage which may be safely imposed. In general, on the lower ranges this is dictated by the maximum grid voltage which the amplifier input tube can withstand without damage. On the higher ranges the maximum voltage rating of components in the input attenuator restricts the maximum voltage which may be safely applied. Table II lists the maximum overload ratios for the various ranges.

TABLE I

INPUT CAPACITANCE VS. RANGE SWITCH SETTING	
Range	Capacitance
0.01 volt	25 uuf
0.1 volt	15 uuf
1.0 volt	15 uuf
10.0 volt	15 uuf
100.0 volt	15 uuf
1000.0 volt	15 uuf

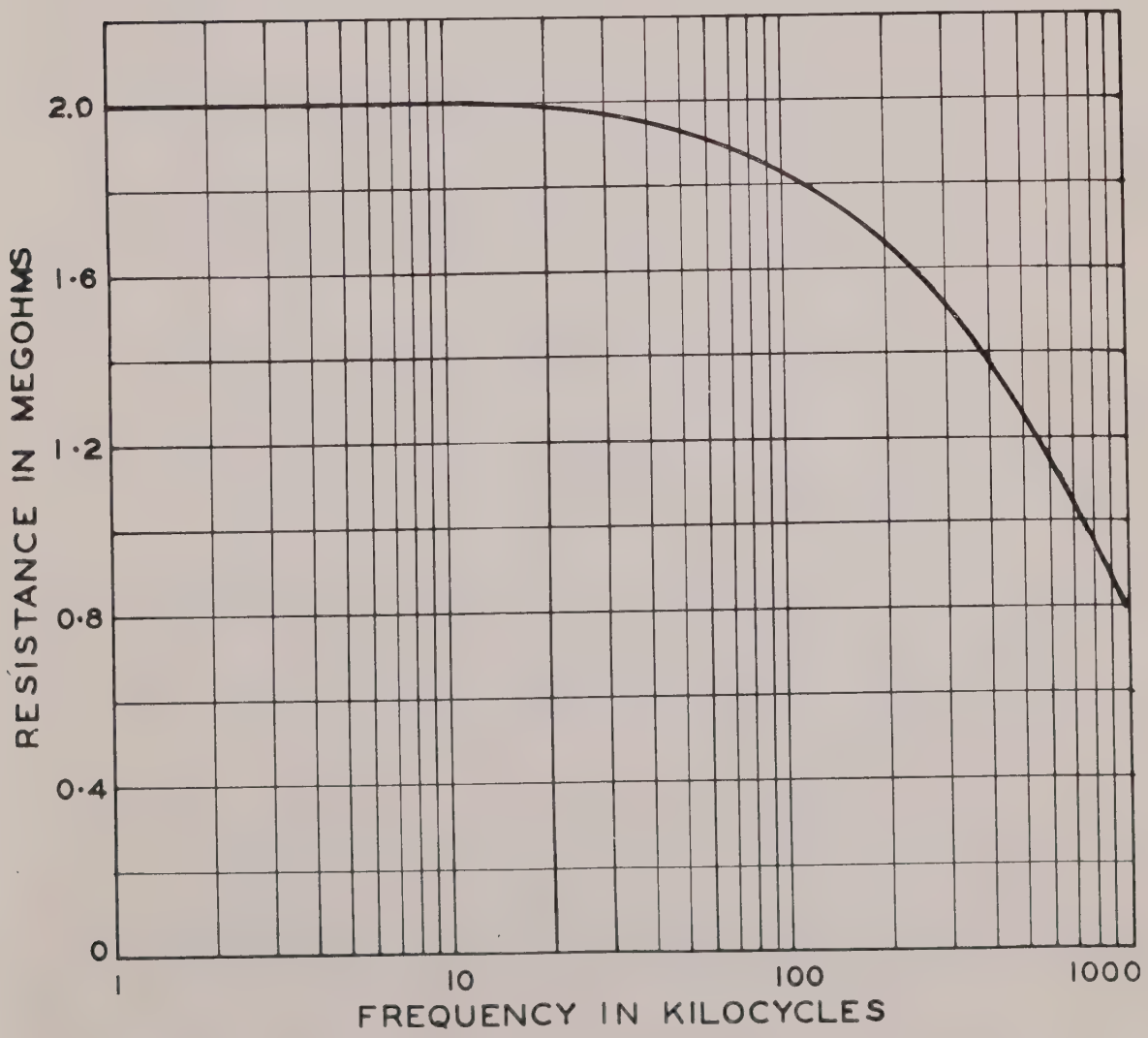


Fig. 1 INPUT RESISTANCE VS. FREQUENCY

TABLE II

MAXIMUM OVERLOAD RATIOS		
RANGE	OVERLOAD RATIO	MAXIMUM INPUT
0.001 - 0.01 volt	10,000 to 1	100 volts
0.01 - 0.1 volt	1,000 to 1	100 volts
0.1 - 1.0 volt	1,000 to 1	1,000 volts
1.0 - 10 volts	100 to 1	1,000 volts
10 - 100 volts	10 to 1	1,000 volts
100 - 1000 volts	1 to 1	1,000 volts

3.3 DC Output

Rotate the function switch to the position marked DC OUT. Connect the voltage to be measured or monitored to the input terminals, observing ground polarization. Connect the output terminals to the desired output device. Rotate the range switch to a range which includes the ac potential to be measured or monitored. If the input voltage is completely unknown rotate the range switch initially to the highest (100 - 1000 volt) range; rotate successively to more sensitive ranges until a suitable output is obtained.

If a dc component is also present when making ac measurements, care must be taken to insure that this dc component does not exceed 600 volts (dc working voltage of input coupling capacitor). In the event that the dc voltage exceeds this value, an additional blocking capacitor, with the necessary dc working voltage, may be placed in series with the input terminal. At the lower frequencies the value of this capacitance must be large enough (0.5 uf at 30 cycles) to prevent degradation of accuracy.

Dependent upon the characteristics of the output monitoring device, the ripple in the output may prove to be too high at the lower frequencies. This ripple may be reduced by connecting a capacitor (not greater than 30 microfarads) across the input of the monitoring device. Care should be taken to insure that this capacitor is not allowed to accumulate charge with open circuit conditions, and then discharged through the output monitoring device; damage would almost certainly result with a moving coil type of instrument.

3.3.1 DC-Output Impedance - The dc output impedance of the Model 710 is approximately 10,000 ohms, and the instrument is calibrated to operate into a 1,000,000 ohm load. Output monitoring devices exhibiting higher input impedances than this must be padded down to this value. Table III gives the value of padding resistors for various loads.

TABLE III

PADDING RESISTANCE FOR VARIOUS LOAD RESISTANCES	
Load Resistance	Padding Resistance
1,000,000 ohms	∞ ohms
2,000,000 ohms	2,000,000 ohms
5,000,000 ohms	1,250,000 ohms
10,000,000 ohms	1,111,111 ohms
∞ ohms	1,000,000 ohms

3.4 Current Measurement

By using the Ballantine Series 600 Precision Shunt Resistors in conjunction with this instrument it is possible to measure AC currents from 1 microampere to 10 amperes. For a complete description of the accuracy, current, and frequency range of these shunt resistors, refer to the Ballantine catalog.

3.5 AC Amplifier

Rotate the function switch to the position marked AMP. Connect the signal to be amplified to the input terminals, observing ground polarization. Rotate the range control to the range which would be used in measuring the input voltage. The output is now available at the output jack located on the front panel and marked AMP OUT.

The maximum voltage gain of the amplifier is 60 db, reducible in steps of 20 db by means of the range switch. The maximum output voltage available is 10 volts, while the output impedance is approximately 300 ohms at midband frequencies. A distortion free output is obtainable with load impedances as low as 15,000 ohms. The open circuit noise level referred to the input terminals will in general be under 40 microvolts for the most sensitive range and under 30 microvolts for all other ranges. The response of the amplifier is flat within 1 db over the range of 30 cycles to 250,000 cycles, for load impedances of not less than 15,000 ohms.

3.6 Voltage Measurement Above 250 Volts

The accuracy of the dc output for ac input in the range of 250 to 1000 volts will be less than that specified for the rest of the voltage range (see Specifications, Page 1). This accuracy degradation is the result of a temperature rise in an attenuator resistor caused by the power dissipated at these higher voltage levels. Since this temperature rise is not instantaneous, some "drift" in dc output will be encountered at the highest input levels before a stable output occurs. Correction for the above mentioned effect may be made with the aid of Fig. 1-A, which is a graph giving the magnitude of this error vs input voltage; the dc output will be greater than the true value by this amount. To obtain the true input voltage, subtract the error shown in Fig. 1-A from the indicated input voltage.

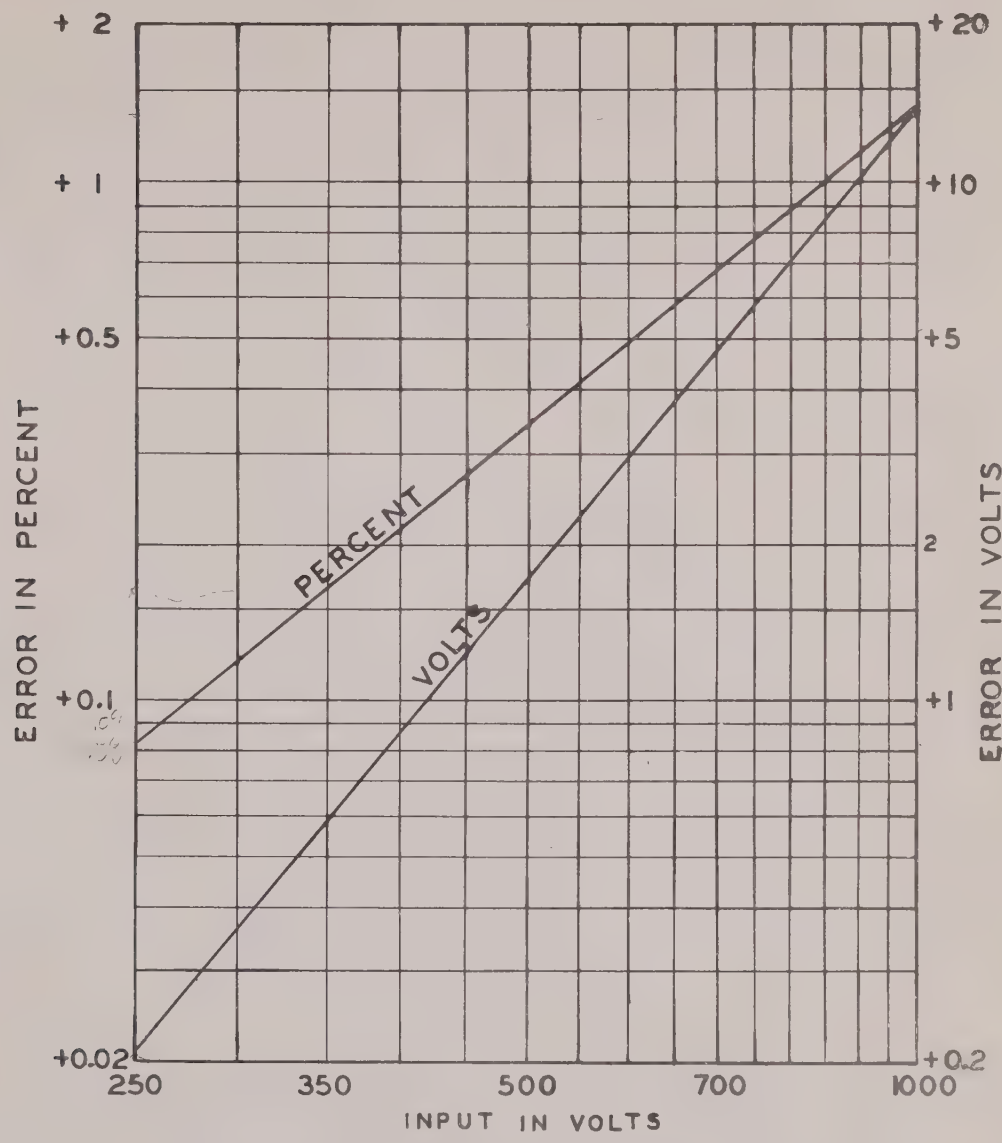


FIG. 1-A. ERROR VS INPUT VOLTAGE FOR THE 250 TO 1000 VOLT RANGE.

4. CIRCUIT DESCRIPTION

A block diagran , schematic, and replacement parts list are included at the end of this instruction book.

4.1 Input Attenuator

Since the amplifier of the Model 710 always operates with the same basic sensitivity (0.001 volt to 0.01 volt), an attenuator must be provided for reducing higher level voltages to this range.

Actually the input attenuator of the Model 710 consists of three separate attenuators. The first provides a reduction of 10 to 1, the second, 100 to 1, the third 1000 to 1, 10,000 to 1, and 100,000 to 1. Table IV is a listing of range switch settings and attenuation ratios.

TABLE IV

ATTENUATOR RATIOS	
Range	Attenuation Ratio
0.01 volt	1
0.1 volt	10
1.0 volt	100
10.0 volts	1,000
100.0 volts	10,000
1,000.0 volts	100,000

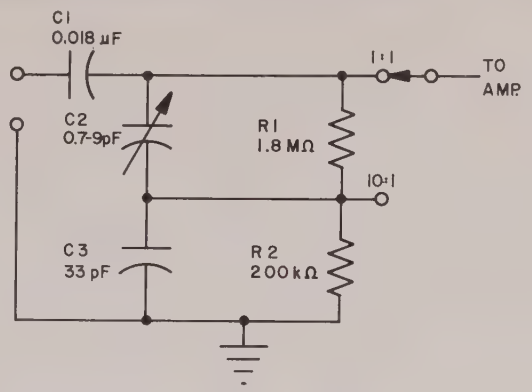
At low frequencies the attenuation ratio is determined solely by the resistors employed. At the higher frequencies, capacitive compensation is necessary to compensate for circuit strays, input capacitance of the amplifier, etc. The crossover from resistive to capacitive attenuator occurs at approximately 25,000 cycles. Figure 2 is a simplified schematic of all three attenuators showing component values. The high frequency response of attenuator No. 1 is adjustable by means of C2, the response of No. 2 by C4, the response of No. 3 by C6. It will be noted that no compensation is employed on the second and third steps of attenuator No. 3, because of the relatively low resistances involved and the negligible reactive components of the resistors. Thus C6 serves to adjust the high frequency response of all three steps of attenuator No. 3. Note - The user is cautioned against making any adjustments of C2, C4, or C6 without first reading Section 5.5.

4.2 Amplifier

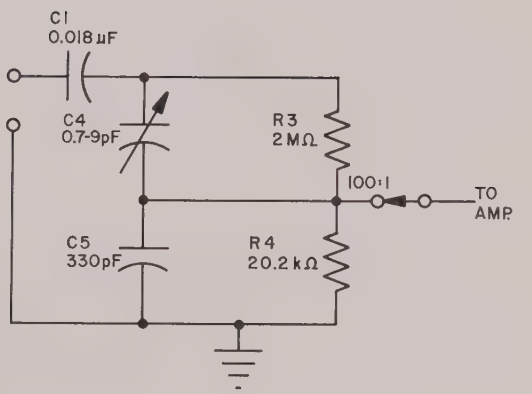
The amplifier consists of four capacitively coupled pentode stages. The first three stages are operated to provide voltage gain while the final stage is used as a transducer to convert voltage to current for the rectifier circuit. When the instrument is operated in its AMP position the fourth stage also provides voltage gain.

Local feedback (8 db, or greater, achieved by unbypassed cathode resistors) as well as overall feedback (32 db or greater) is employed to minimize distortion and gain changes from whatever cause. The amplifier response without feedback is shaped to fall off from the midband value at a rate of approximately 6 db per octave. As a result of this and the amount of feedback available, the stability of the amplifier at the band extremes (30 cycles and 250,000 cycles) is essentially that of midband.

ATTENUATOR NO. 1



ATTENUATOR NO. 2



ATTENUATOR NO. 3

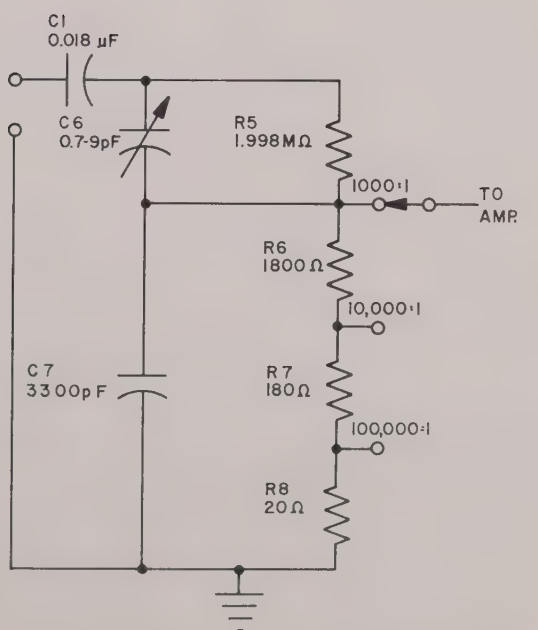


Fig. 2 ATTENUATOR, SIMPLIFIED SCHEMATIC

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The high frequency response of the instrument is adjustable over a narrow range by means of L1. See Section 5.5. The gain or sensitivity of the instrument is adjustable over a small range by means of R16 in the feedback network. See Section 5.3.

The heater of the input amplifier stage is operated on DC to minimize the line frequency component injected in this low level stage. Thus the error introduced when measuring voltages of line frequency and its harmonics is substantially reduced.

4.3 Rectifier

AC current, available from the last amplifier stage, is passed through the rectifier circuit and the feedback network to ground.

The rectifier is of the half wave type employing semiconductor diodes, and direct current from it passes through Resistor R39. The capacitor across R39 serves to reduce the ripple at the lower frequencies. The response of the circuit is average.

The signal rectifiers are hermetically sealed, small-area silicon junction diodes which are virtually immune to aging and environmental conditions. The inherently non-linear characteristic of the diode rectifier is reduced to almost negligible proportions by incorporating the rectifier circuit within the feedback loop. Resistors R41, R42, and R43 provide a mean for correcting the small remaining non-linearity in this circuit.

4.4 Power Supply

Amplifier plate and screen voltages are obtained from a full wave vacuum tube rectifier employing an RC filter, and gaseous regulator tube. Low voltage DC power for the first amplifier stage heater is obtained from a full wave rectifier employing hermetically sealed silicon junction diodes, and a capacitance filter. All other amplifier heaters are operated on AC balanced with respect to ground.

5. MAINTENANCE AND SERVICE

Limited servicing of the instrument by the user is feasible, providing the procedures outlined in this section are followed. However, it cannot be too strongly emphasized that the work should be entrusted only to technicians having the highest skill and experience in measurement techniques. A refined and comprehensive method of recalibration is beyond the scope of this manual and cannot be effected without specialized equipment having an order of accuracy much greater than that of the instrument being checked. Such equipment and personnel trained in its use are available in the Calibration Department of Ballantine Laboratories, Inc., so that if trouble develops which cannot be corrected except by the replacement of special components, or if the user is not equipped with the necessary test equipment, it is recommended that the instrument be returned to Ballantine Laboratories, Inc. for servicing. The instrument should in all cases be preceded by a letter indicating the fault or desired service.

5.1 General Instructions

5.1.1 Fuse and Pilot Lamp Replacement - The fuse is of the Slo-Blow type and is rated at 0.4 ampere for 115 volt operation and 0.2 ampere for 230 volt operation. The fuse holder is of the extractor post type located on the front panel.

The pilot lamp, Type 47, is accessible by unscrewing the red plastic cap located on the front panel.

5.1.2 Line Voltage Conversion - It is possible to operate the Model 710 from either a 115 volt or 230 volt line supply. The line voltage for which the instrument is connected on leaving the factory is indicated on a decal located adjacent to the power cord emergence point. To convert from 115 volt to 230 volt operation, or vice versa, see the schematic diagram located at the back of this manual.

5.1.3 General Malfunction - In case of malfunction, as evidenced by insufficient or even absence of instrument output, instability, high hum or noise level, intermittent operation or other disturbance, the first step is to check all tubes, replacing any which exhibit low gm, grid current, shorts, etc.

With all tubes operating normally the voltages at the tube elements may be measured and checked against Table V. All measurements should be made with the Model 710 range switch on the most sensitive range, the input terminals short circuited, and the OFF-DC OUT-AMP switch in the AMP position.

NOTE - THE USER IS CAUTIONED TO TAKE EXTREME CARE WHEN MAKING MEASUREMENTS IN THE SIGNAL RECTIFIER PORTION OF THE INSTRUMENT - OTHERWISE DAMAGE TO THE SIGNAL DIODES MAY RESULT.

The instrument used to measure DC should have an input resistance of not less than 10 megohms. Any radical departure from the voltages indicated in Table V may indicate the nature of the trouble

In the event of a defective component it should be replaced in accordance with the Replacement Parts List located at the end of this manual. If the component or components are not available locally, they may be obtained from Ballantine Laboratories, Inc.

TABLE V

TUBE ELEMENT POTENTIALS

Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7
V1 6AU6	0 to ±0.1v	1.40v	3.10v	3.10v	56v	62v	1.40v
V2 6AU6	0 to ±0.1v	1.45v	*3.15v	*3.15v	62v	85v	1.45v
V3 6AU6	0 to ±0.1v	1.45v	*3.15v	*3.15v	92v	90v	1.45v
V4 6AU6	0 to ±0.1v	1.55v	*3.15v	*3.15v	74v	120v	1.55v
V5 0A2	150v	0	-	0	150v	-	0
V6 6X4	*360v	-	*6.3v to Pin 4	*6.3v to Pin 3	-	*360v	390v

All measurements made with respect to chassis ground unless otherwise indicated. All voltages DC unless otherwise indicated. *AC voltages.

5.2 Linearity Adjustment

When an undistorted sine wave signal produces an output of precisely 1 V on a given range, switching to the next higher range should produce an output of precisely 0.1 volt. During the instrument calibration at Ballantine Laboratories, Inc. the instrument is very carefully adjusted for this condition and it should seldom, if ever, be found necessary to readjust. In the event that readjustment does become necessary, the control relating thereto is R42, and is available through an access hole in the right-hand side of the instrument case. See Figure 3.

To make the linearity adjustment, connect an undistorted sine wave of midband frequency (400-1000 cycles) to the input terminals and adjust the amplitude for an output of precisely 1 volt on any range (except the 1000 volt range). Switch the attenuator to the next higher range. The output should be precisely 0.1 volt. If the output is not precisely 0.1 volt, correct by means of control R42. Recheck and readjust if necessary.

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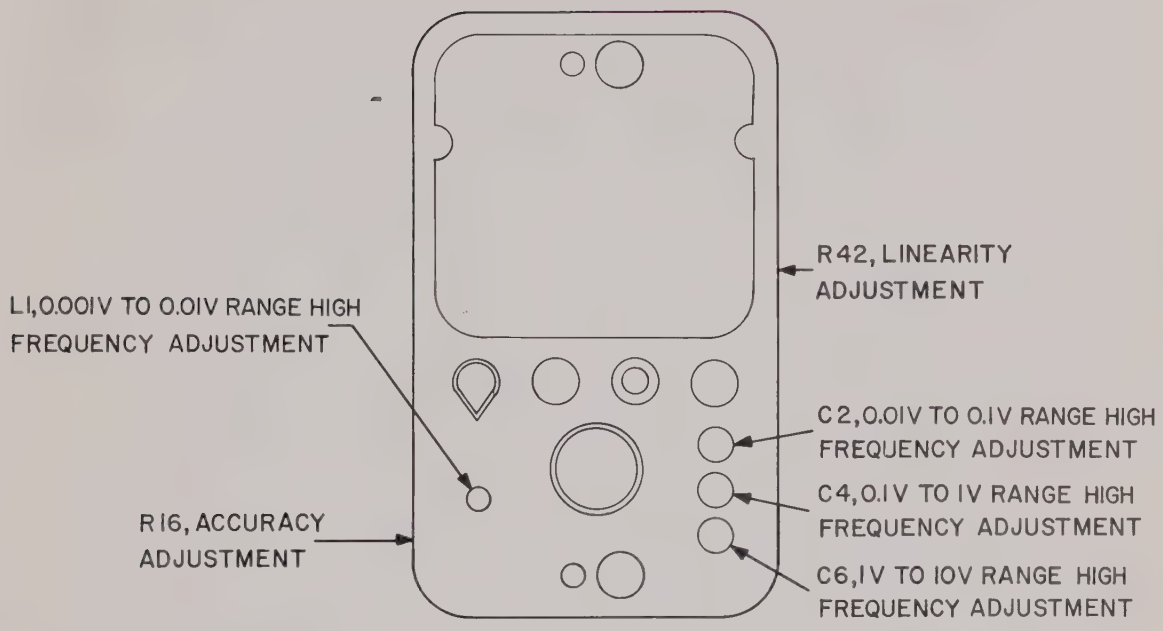

Fig. 3. INSTRUMENT ADJUSTMENTS

Access to L1, C2, C4, and C6 is obtained by removing the two knobs, and then the engraved escutcheon plate. NOTE — Read Sections 5.2, 5.3 and 5.5 before readjusting any of the above.

5.3 Accuracy Adjustment

The design of the Model 710 is such that it should maintain its accuracy over extended periods of time and use. At Ballantine Laboratories this accuracy is very carefully adjusted and checked. Moreover an attempt is made to distribute the various inherent errors so that the best possible overall accuracy results. Therefore, the user is cautioned against making any readjustments without fully determining that the instrument is in error.

All checks of accuracy should be made with an undistorted sine wave signal at a midband frequency (400 - 1000 cycles). The external standard should be accurate to 0.05% or better, and preferably of the RMS responding type.

If it has been established that the instrument is in error, the first attempt at correction should be tube replacement. Access to the tubes may be had by removing the four nickel plated screws along the panel edges, and then removal of the instrument from the instrument case.

If tube replacement does not restore accuracy, a small adjustment is possible with control R16 available through an access hole in the left-hand side of the case. A larger adjustment is possible by changing the value of R17, although the necessity to change this value is good indication that something is at fault in the instrument. See Figure 3.

To adjust the accuracy, first check the Linearity Adjustment as outlined in Section 5.2 and readjust if necessary. Next connect an undistorted sine wave signal of midband (400 - 1000 cycles) frequency to the input terminals and check the accuracy. Readjust R16 as necessary.

5.4 Attenuator Decading

When the input to the instrument is increased or decreased by precise factors of 10, and the range switch is changed accordingly, the output of the instrument should not vary by more than ±0.1%. Thus, if the instrument output is 0.5 volt on a given range, increasing the input by a factor of 10 ±0% and switching to the next higher range should produce an output of 0.5 volt ±0.1%. Decading checks should be made with an undistorted sine wave signal of midband frequency (400 - 1000 cycles).

There are no controls or adjustments relating to the attenuator decading, this factor being solely determined by the attenuator resistors. If it is discovered that the decading is in error, in all probability one or more of the attenuator resistors has changed in value. However, some other possible sources of difficulty are -

1 - Grid current in the amplifier input tube, V1

2 - Misadjustment of capacitors C2, C4 or C6. Note - No adjustments of C2, C4, or C6 should be made without reference to Section 5.5.

The resistors employed in the attenuator are hermetically sealed film type of advanced design, exhibiting a stability approaching that of wirewound units but free from the reactive effects inherent in the latter. Initially the resistors are selected to a tolerance of ±0.1%; in addition the temperature coefficients of the various values are closely matched. In view of the above it is recommended that the instrument be returned to Ballantine Laboratories, Inc. for attenuator repairs.

5.5 High Frequency Response

A discussion of all the factors entering into the high frequency response of this instrument is beyond the scope of this manual. There are however a number of adjustments connected with this response and a procedure for making these adjustments will be outlined. All checks of response must be made with a distortion free sine wave signal, and the instrument used as a reference must have extremely low error over the range of 400 cycles to 250,000 cycles.

On the most sensitive range of the Model 710 the response is determined by the amplifier and rectifier circuit. On all other ranges the attenuator response enters in also.

If it has been determined that the instrument is in error at the higher frequencies, the response of the most sensitive or amplifier range should be checked. If this range is found normal, the trouble must be in one or more of the attenuators employed.

If the most sensitive range response is not normal the first attempt at correction should be tube replacement. If tube replacement does not restore normal response, a limited amount of adjustment is available by means of variable inductor L1, available through an access hole in the front panel. Removal of the engraved escutcheon plate provides access to L1, C2, C4 and C6. See Figure 3. L1 affects the response only at the higher frequencies and should be adjusted for the flattest response with respect to midband. If adjustment of L1 does not restore normal response, it is recommended that the instrument be returned to Ballantine Laboratories, Inc. for servicing.

If the response of the most sensitive range is normal but errors exist on attenuator ranges, the adjustments are as follows.

1 - 0.1 Volt Range - Adjust C2 for flattest response or best agreement with most sensitive range.

2 - 1.0 Volt Range - Adjust C4 for flattest response or best agreement with most sensitive range.

3 - 10 Volt Range - Adjust C6 for flattest response or best agreement with most sensitive range. The adjustment on this range also takes care of the 100 and 1000 volt ranges.

If the above procedure fails to establish normal response on an attenuator range, capacitors C2, C3, C4, C5, C6 and C7 may be suspect. Access to C3, C5, and C7 may be had by removal of the attenuator shield affixed to the rear of the attenuator switch by means of two machine screw nuts. Access to capacitors C2, C4 and C6 is not possible without removal of the entire attenuator unit. If this appears necessary it is recommended that the instrument be returned to Ballantine Laboratories, Inc. for servicing.

5.6 Low Frequency Response

There are no adjustments relating to the low frequency response. Should trouble be encountered, the following items should be checked.

1 - All tubes for gm, grid current, shorts, etc. Tube replacement is the simplest method.

2 - All coupling capacitors for proper capacitance and leakage.

3 - All plate and screen decoupling capacitors for capacitance.

6. WARRANTY

Each Ballantine Laboratories, Inc. instrument, or part thereof, is warranted to be free from defects in material and workmanship. Ballantine Laboratories, Inc. obligation under this warranty is limited to repairing or replacing any instrument or part thereof, except vacuum tubes, which shall within one year after shipment to the original purchaser prove upon Ballantine Laboratories, Inc. examination to have become defective.

7. SHIPPING INSTRUCTIONS

If it should become necessary to return the instrument or any part thereof to Ballantine Laboratories, Inc. for examination or servicing - AT LEAST 4 INCHES OF PACKING MATERIAL SHOULD BE PLACED AROUND ALL SIDES OF THE INSTRUMENT TO PREVENT DAMAGE DURING SHIPMENT. Ship via RAILWAY EXPRESS or MOTOR TRUCK and send under separate cover a full description of the trouble or defect.

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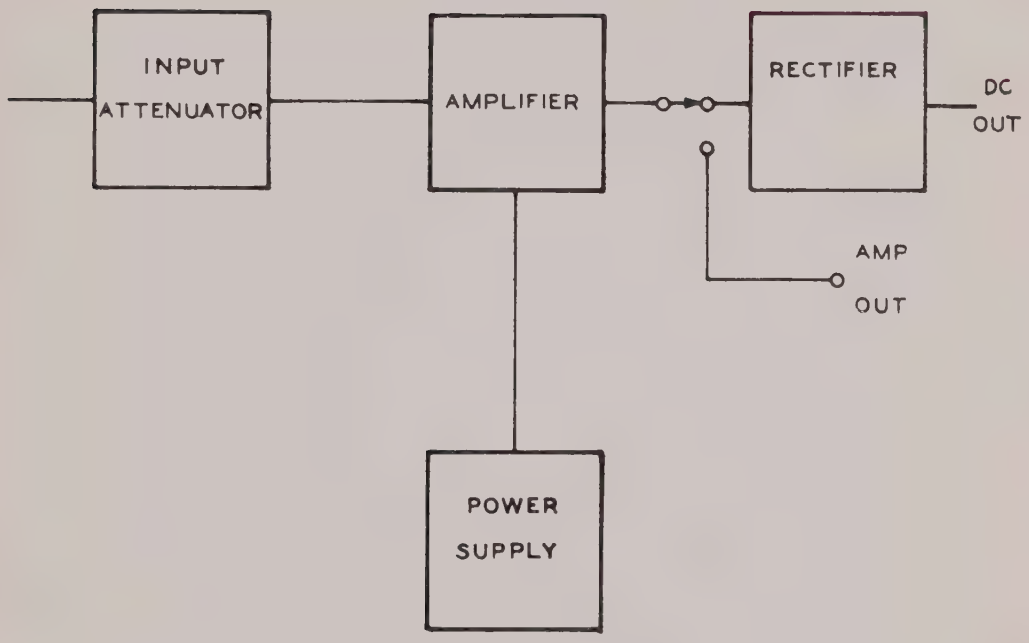

BLOCK DIAGRAM

MODEL 710 LINEAR AC TO DC CONVERTER

REPLACEMENT PARTS LIST

REFER TO MODEL 710 SCHEMATIC DIAGRAM, ISSUE MC-1217F

B. L. PART #	CIRCUIT SYMBOL	RESISTORS	MANUFACTURER
1476	R1	1,800,000 ohms, Type PT-1000	Ballantine
1441	R2	200,000 ohms, Type PT-500	Ballantine
1477	R3	2,000,000 ohms, Type PT-1000	Ballantine
1442	R4	20,200 ohms, Type PT-500	Ballantine
1477	R5	2,000,000 ohms, Type PT-1000	Ballantine
1443	R6	1,800 ohms, Type PT-500	Ballantine
1444	R7	180 ohms, Type PT-500	Ballantine
1445	R8	20 ohms, Type PT-500	Ballantine
1081	R9	27,000 ohms, Type EB, 5%	Allen-Bradley
1660	R10	47,000 ohms, Type N20, 1%	Corning Glass
1097	R11	47 ohms, Type EB, 5%	Allen-Bradley
1327	R12	5,000 ohms, Type CP-1/2, 1%	Wilkor
1085	R13	120,000 ohms, Type EB, 5%	Allen-Bradley
1100	R14	1,200 ohms, Type EB, 5%	Allen-Bradley
1348	R15	250 ohms, Type CP-1/2, 1%	Wilkor
1921	R16	10,000 ohms, Type J Pot, 20%	Allen-Bradley
	R17	Value determined in calibration	
1769	R18	7.35 ohms	Ballantine
1042	R19	15,000 ohms, Type EB, 5%	Allen-Bradley
1322	R20	12,000 ohms, Type CP-1/2, 1%	Wilkor
1325	R21	7,500 ohms, Type CP-1/2, 1%	Wilkor
1039	R22	22,000 ohms, Type EB, 5%	Allen-Bradley
1007	R23	2,000,000 ohms, Type EB, 5%	Allen-Bradley
1007	R24	2,000,000 ohms, Type EB, 5%	Allen-Bradley
1009	R25	1,500,000 ohms, Type EB, 5%	Allen-Bradley
1061	R26	510 ohms, Type EB, 5%	Allen-Bradley
1046	R27	7,500 ohms, Type EB, 5%	Allen-Bradley
1324	R28	10,000 ohms, Type CP-1/2, 1%	Wilkor
1081	R29	27,000 ohms, Type EB, 5%	Allen-Bradley
1007	R30	2,000,000 ohms, Type EB, 5%	Allen-Bradley
1007	R31	2,000,000 ohms, Type EB, 5%	Allen-Bradley
1010	R32	1,000,000 ohms, Type EB, 5%	Allen-Bradley
1062	R33	390 ohms, Type EB, 5%	Allen-Bradley
1365	R34	19,000 ohms, Type CP-1/2, 1%	Wilkor
1042	R35	15,000 ohms, Type EB, 5%	Allen-Bradley
1010	R36	1,000,000 ohms, Type EB, 5%	Allen-Bradley
1063	R37	300 ohms, Type EB, 5%	Allen-Bradley
1655	R38	694 ohms, Type N-20, 1%	Corning Glass
1866	R39	1,667 ohms, Type M-50, 1%	Mepco

REPLACEMENT PARTS LIST

REFER TO MODEL 710 SCHEMATIC DIAGRAM, ISSUE MC-1217F

B.L. PART #	CIRCUIT SYMBOL	RESISTORS	MANUFACTURER
1367	R40	8,000 ohms, Type CP-1/2, 1%	Wilkor
1427	R41	138,000 ohms, Type DC-1/2, 1%	Electra
1924	R42	1,000 ohms, Type J Pot, 20%	Allen-Bradley
1450	R43	2,500,000 ohms, Type CP-1/2, 1%	Wilkor
1329	R44	4,700 ohms, Type CP-1/2, 2%	Wilkor
1331	R45	3,000 ohms, Type CP-1/2, 1%	Wilkor
1005	R46	3,000,000 ohms, Type EB, 5%	Allen-Bradley
1719	R47	4,000 ohms, Type 27E, 5%	Sprague
1719	R48	4,000 ohms, Type 27E, 5%	Sprague
1061	R49	510 ohms, Type EB, 5%	Allen-Bradley
1057	R50	1,000 ohms, Type EB, 5%	Allen-Bradley
1044	R60	10,000 ohms, Type EB, 5%	Allen-Bradley
1044	R61	10,000 ohms, Type EB, 5%	Allen-Bradley

REPLACEMENT PARTS LIST

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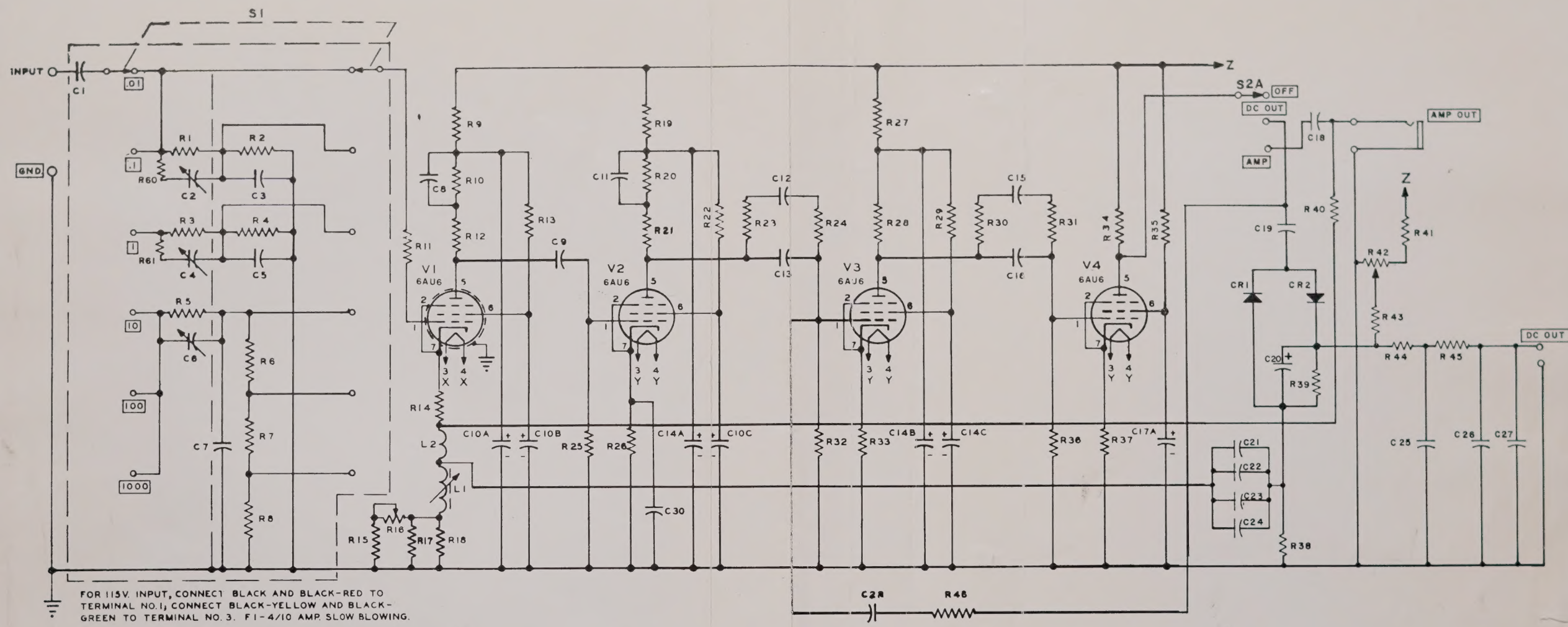
B. L. PART #	CIRCUIT SYMBOL	CAPACITORS	MANUFACTURER
2377	C1	.018 μF, Type 355F183J, 600 V	Gudeman
2437	C2	0.5-8 pF, Type VC1G, 1000 V	JFD
2235	C3	33 pF, Type CM15-E-330K, 5%, 500 V	Arco
2437	C4	0.5-8 pF, Type VC1G, 1000 V	JFD
2254	C5	330 pF, Type CM15-E-331K, 5%, 500 V	Arco
2437	C6	0.5-8 pF, Type VC1G, 1000 V	JFD
2253	C7	3300 pF, Type CM-30-E-332K, 5%, 500 V	Arco
2228	C8	50 pF, Type CM15-E-500-J, 5%, 500 V	Arco
2364	C9	.033 μF, Type 355C333J, 5%, 200 V	Gudeman
2042	C10A	50 μF, Type FP, 150 V	Magnavox
2042	C10B	50 μF, Type FP, 150 V	Magnavox
2042	C10C	50 pF, Type FP, 150 V	Magnavox
2240	C11	20 pF, Type CM15-C-200J, 5%, 500 V	Arco
2362	C12	.22 μF, Type 35SC224J, 5%, 200 V	Gudeman
2365	C13	.01 μF, Type 355C103J, 5%, 200 V	Gudeman
2042	C14A	50 μF, Type FP, 150 V	Magnavox
2042	C14B	50 μF, Type FP, 150 V	Magnavox
2042	C14C	50 μF, Type FP, 150 V	Magnavox
2362	C15	.22 μF, Type 35SC224J, 5%, 200 V	Gudeman
2366	C16	.0022 μF, Type 355C222J, 5%, 200 V	Gudeman
2043	C17A	10 μF, Type FP, 500 V	Magnavox
2043	C17B	10 μF, Type FP, 500 V	Magnavox
2043	C17C	10 μF, Type FP, 500 V	Magnavox
2319	C18	2 μF, Type PUP, 5%, 200 V	Cornell Dubilier
2361	C19	2 μF, Type 355C205J, 5%, 200 V	Gudeman
2578	C20	30 μF, Type CL44BB300SP, 6 V	Fansteel
2577	C21	c 325 μF, Type PP325B6A2, 6 V	Fansteel
2577	C22	325 μF, Type PP325B6A2, 6 V	Fansteel
2577	C23	325 μF, Type PP325B6A2, 6 V	Fansteel
2577	C24	325 μF, Type PP325B6A2, 6 V	Fansteel
2373	C25	.047 μF, Type 355C473M, 20%, 200 V	Gudeman
2373	C26	.047 μF, Type 355C473M, 20%, 200 V	Gudeman
2246	C27	1,500 pF, Type CCD-152, 20%, 500 V	El Menco
2512	C28	1 pF, Type QC, 5%, 500 V	Quality Components
2019	C29	1,000 μF, Type FP, 15 V	Magnavox
2257	C30	200 pF, Type DM-15-201-K, 10%, 500 V	Arco

REPLACEMENT PARTS LIST

REFER TO MODEL 710 SCHEMATIC DIAGRAM, ISSUE MC-1217F

B. L. PART #	CIRCUIT SYMBOL	OTHER COMPONENTS	MANUFACTURER
3053	T1	Power Transformer	Ballantine
3410	F1	Fuse, 0.4 amp, Slo-Blow	Bussman
5564	V1, 2, 3, 4,	Type 6AU6WA Tube	R.C.A.
3106	V5	Type OA2 Tube	R.C.A.
3105	V6	Type 6X4 Tube	R.C.A.
5573	CR1, 2	Diodes, Type S282G	Transitron
5559	CR3, 4	Diodes, Type TM1	Transitron
3012	L1	Variable Inductor	Ballantine
3013	L2	Inductor, CL4, 1.2 uh	I.R.E.
3255	S1	Range Selector Switch	Ballantine
3256	S2A	Function Switch	Ballantine
3256	S2B	Function Switch	Ballantine
3451	I1	Lamp, Type 47	G.E.



AC-DC Linear Converter
Model 710 Issue MC-1217F

BALLANTINE LABORATORIES, INC.
BOONTON, N. J.

E/E SYSTEMS LABORATORY

MP MASTER
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